IV. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The unavoidable adverse environmental effects from the routine operations of INEL waste systems result primarily from the atmospheric releases from the various facilities. At present two facilities, TRA and ICPP, contribute greater than 99% of the radionuclides released to the atmosphere. The radionuclides released from these facilities are primarily the noble gases argon-41 and krypton-85. During 1974, 4,128 Ci of argon-41 and 253,900 Ci of krypton-85 were released into the atmosphere from INEL operations. This resulted in a calculated exposure to a person at the INEL boundary of 0.22 mrem, which can be compared with the 150 mrem from existing natural background. The release of low levels of noble gases can be expected to continue, with the level dependent upon the programmatic requirements at INEL and the timing of the installation of additional cleanup systems. Because of the 10-yr half-life of krypton-85, INEL releases will continue to add infinitesimally to the global atmospheric burden of this isotope.

Although there are plans to reduce the quantity of radionuclides that are presently being introduced into the lithosphere, the continued release of small quantities of tritium into the Snake River Plain aquifer at ICPP and TRA can be expected. As indicated in Section III, the dispersion of tritium in the aquifer has been studied and measured extensively. The environmental impact associated with the disposal of tritium to the aquifer has been determined to be minor and limited to the area within the boundaries of INEL. Even after 20 yr of discharge, tritium is below the minimum detection limit 3.5 mi inside the site boundary.

The annual radiological dose commitment (based on 1974 data) to onsite personnel consuming water from the nearest downgradient production well (CFA) was calculated to be 4.0 mrem. This dose is about 20% of the annual dose from the naturally occurring radioactive potassium-40 present in the human body. Mathematical models of tritium within the aquifer show that concentrations at INEL boundary are at background levels and are not expected to increase, based on current disposal rates.

The continued management of waste disposal/storage areas represents an unavoidable program of perpetual surveillance or ultimate disposal.

The continued release of chemical and industrial waste to the atmosphere and lithosphere may also represent a possible unavoidable impact upon the environment. The impact from these wastes is only minimal and confined to localized areas within the boundaries of INEL. There are no identifiable adverse effects upon man from these releases in the forseeable future.

Although abnormal occurrences are not expected, the possibility of such events cannot be eliminated, and therefore they represent possible unavoidable adverse effects. Waste process and storage systems have been designed to rigid standards, and management controls have been imposed to prevent abnormal occurrences. The impact of postulated events was discussed in Section III.C., and based on these studies, the most probable adverse impact could be expected to be the localized contamination of the lithosphere from spills resulting from transportation accidents or leaks in low-volume, low-radioactivity liquid holding tanks.

V. ALTERNATIVES

A. GENERAL CATEGORIES OF ALTERNATIVES

Since its startup in 1952, INEL has been successful in developing nuclear engineering concepts, in testing and operating many kinds of reactors, and in instituting nuclear and nonnuclear waste management systems in response to programmatic and regulatory requirements. An integral part of INEL philosophy always has been to ensure that releases of potentially harmful substances do not reach unacceptable levels. To achieve this goal and to reduce even further, changes in operations and procedures, made possible as technology has advanced, have been incorporated in INEL waste management systems. Technological improvements in waste management operations will continue to be instituted as they become practicably available. The INEL Waste Management Plan IDO-10051[4], published annually, describes ERDA's policy and plans for ensuring that releases at INEL continue to be reduced to levels as low as reasonably achievable.

Because of the history of successful operations at INEL, one of the major alternatives concerning future INEL operations is to continue ongoing activities as at present with waste effluent releases being below federal and state guidelines. Section III of this environmental statement identifies the resultant environmental impacts from present waste management operations at INEL, and demonstrates that continuing operations will cause minimal perturbations to the existing quality of the environment. However, there are other alternatives to the generation or release of waste at INEL. These alternatives may be grouped into general categories of options for waste management operations. Besides the choice of continuing INEL operations as in the immediate past, the other primary categories of alternatives are:

(1) Shut down operations at INEL, and either transfer those operations to another site location or forego the benefit of the operations

(2) Continue operations at INEL, but modify operations to reduce or eliminate releases of wastes.

These general categories of alternatives are displayed schematically in Figure V-1. Section IX provides a cost-benefit analysis of some of the specific alternatives mentioned in this section of the statement.

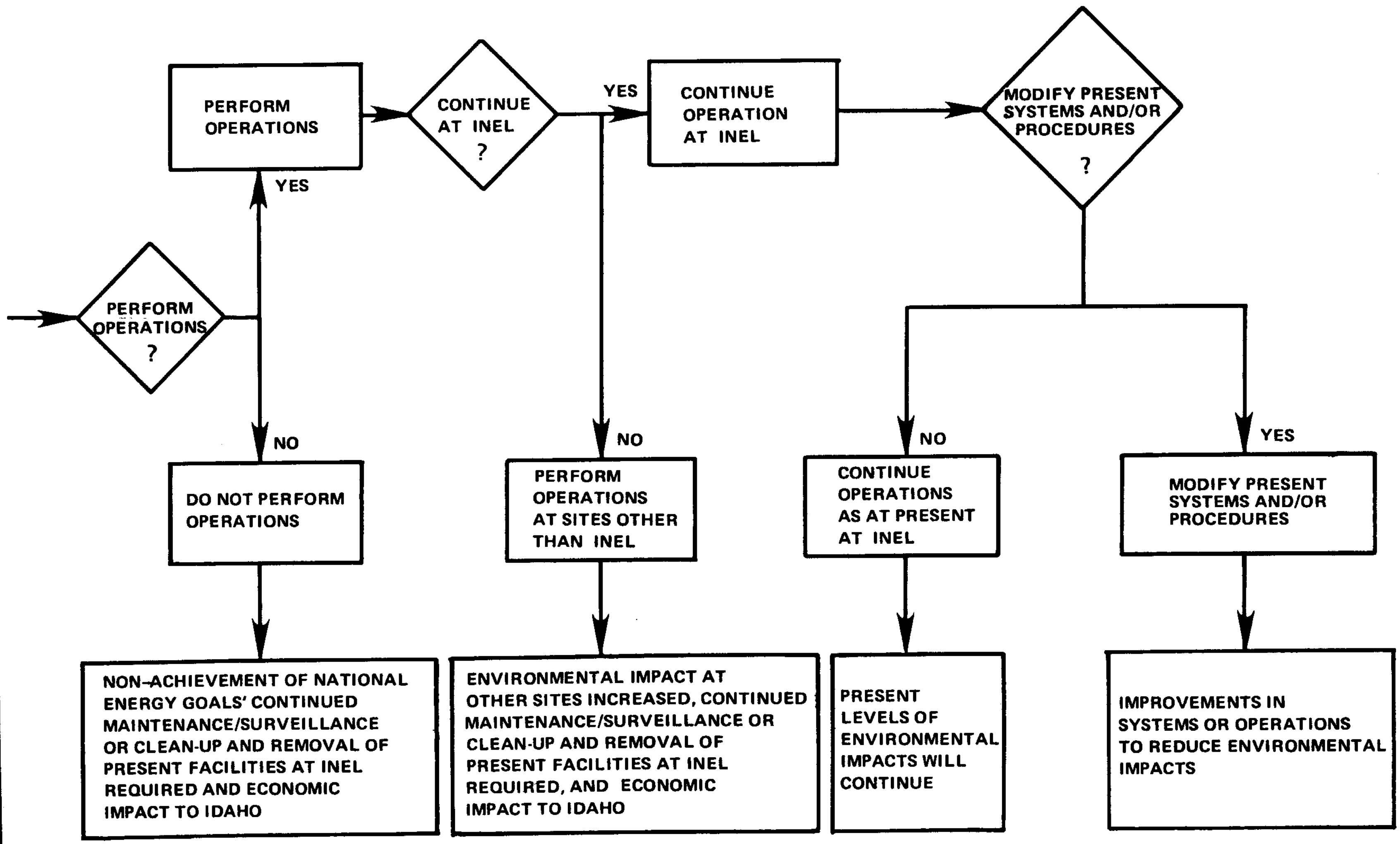

Figure V-1. Schematic of Categories of Alternatives for Operations at INEL.

1. Shutdown of INEL Operations

Total cessation of waste generating operations now performed at INEL is an alternative to the generation of additional wastes. The consequences of implementing this type of alternative include impeding achievement of national defense and energy independence goals, imposition of continued maintenance and surveillance of presently contaminated facilities and wastes (or restoration of the site with attendant generation of wastes in cleanup operations), and adverse effects on local and national economies.

Consideration could be given to continuing INEL operations that do not produce wastes. The reactors and ICPP are the primary sources of radioactive waste products at INEL. An obvious alternative to generation of wastes from reactors at INEL is to shut down the reactors. However, the highly specialized test reactors at INEL contribute important information vital to the development of the nation's energy programs and data for defense applications of nuclear power.

Wastes are produced at ICPP from reprocessing of irradiated nuclear fuel. Another alternative to release of wastes at INEL, then, is to discontinue operations at ICPP. ICPP is the only facility in the country where specialized test and military reactor fuels are safely and efficiently processed on a production basis. ICPP is a highly specialized and complex plant capable of reprocessing many different kinds of nuclear fuels contained in various kinds of fuel element cladding materials. Its proximity to the experimental reactors and irradiated fuel element examination facilities at INEL enables it to handle safely and efficiently fuel from both of these sources.

The transfer of the ongoing waste generating operations at INEL to other locations is possible. Performance of these operations at other sites would lead to generally similar production of wastes. Institution of a program for continuing maintenance and surveillance or removal of contaminated facilities also would be required. Transfer of operations, then, would not eliminate the environmental impacts associated with INEL-type operations, but merely would shift waste management efforts and impacts to some other locality. However, at another site some reduction of overall impacts possibly could result from different operational methods and procedures, from differences in transportation of waste products, and from changes in climatological and demographic factors. These differences could be of sufficient magnitude to justify a change in site location. To assess the advantages of this alternative, the benefits and costs involved must be compared with those from current INEL operations.

As described in Section III of this document, the current total population exposure to radioactivity from INEL operations in a 50-mi radius is about 2 man-rem/yr. A portion of this dose could be avoided in the affected locations in Idaho by moving INEL operations to another site where some dose similar to that from INEL operations also would occur. Nevertheless, a small residual dose commitment would remain in Idaho by virtue of the contaminated facilities now at INEL. Decontamination and removal efforts for these facilities potentially could involve a small short-term dose increment. It is possible to select an alternate site with a shorter distance across which wastes must be transported for handling and storage. To date, however, there have been no significant cases of general population exposure resulting from shipments of waste products to INEL. Thus, the benefits that might accrue from transferring all INEL operations to another site do not justify the cost which, based on 1974 costs, would include more than $540 million in capital costs. The delays and the redundant commitment of natural resources required in licensing and construction of new facilities are additional negative factors associated with relocation of INEL operations. The impacts to Idaho from loss of over $100 million in INEL related expenditures per year and displacement of over 6,000 workers and their families also contribute to the conclusion that the transfer of all INEL functions to another location is not environmentally or economically viable.

Transfer of only some of the operations now performed at INEL is a possible subcategory of alternatives. To attempt to perform reactor operations at other sites would be prohibitively expensive since construction of new specialized test reactors would be required at the alternate site. Additionally, reactors built at another site would release generally similar waste products; hence, there is no incentive, based on a reduction in waste production, for relocating reactor operations to an alternative location.

Transfer of ICPP operations has been considered. Noncommercial irradiated fuel is sent over long distances to INEL from offsite locations for examination and reprocessing. This fuel possibly could be reprocessed elsewhere, eliminating the long transit distances. However, no other existing reprocessing plants have either the ability or capacity to reprocess efficiently the fuel sent to INEL; these plants would also produce similar amounts of radioactive wastes and environmental impacts. To construct a new reprocessing facility at an alternate location would require redundant commitment of resources and is not feasible as long as ICPP can handle efficiently the volumes of fuel involved. Therefore, continued use of the existing reprocessing plant is judged to be the most favorable alternative.

2. Modification of INEL Operations

The second major category of alternatives to present operations at INEL involves modifying the present waste handling systems and changing operational procedures, methods, and schedules in order to reduce or eliminate the quantities of wastes produced and to lessen the subsequent environmental impacts. These potential modifications and changes are compatible with the INEL management philosophy of reducing potential environmental impacts to levels as low as are reasonably achievable. As improved methods and process technologies become available, they are incorporated, where practical, into the present INEL waste generating operations to further reduce releases of potentially harmful substances to the environment.

Decisions concerning cessation or transfer of INEL operations are beyond the scope of this environmental statement on waste management operations. Consequently, the balance of this section will present in more detail the specific alternatives involving modification to ongoing operations.

B. ALTERNATIVES FOR RADIOACTIVE AIRBORNE WASTES

In this section, the alternatives concerning modifications to systems for handling airborne radioactive waste are addressed for each of the major types of sources of these wastes. Table V-1 summarizes INEL sources of radioactive airborne waste for 1974.

TABLE V-1

AIRBORNE RADIOACTIVE WASTE SUMMARY FOR 1974[a]

Facility	Volume ft^3	Volume %	Radioactivity (Curies)	Radioactivity %
ANL	6.4 (10)[b]	25.8	666	0.2
ARA	8.8 (8)	0.4		0
CPP	5.9 (10)	23.9	259,900	90.4
NRF	7.5 (10)	30.0	2	<0.1
PBF	4.4 (9)	1.8	<1	<0.1
TAN	2.2 (10)	8.8	<1	<0.1
TRA	2.4 (10)	9.6	26,960	9.4
Totals	2.5 (10)	100	287,528	100

[a] Data from IDO-10054 (74) RWMIS 1974 Summary

[b] 6.4 (10) = 6.4×10^{10}

1. Alternatives for Radioactive Airborne Wastes from INEL Reactors

a. Curtailment of Operations

An alternative to generation of airborne wastes from INEL reactors would be to reduce the scope or duration of tests conducted in the test reactors. However, because of the costs associated with reactor operations, programmatic requirements for reactor testing are designed to maximize efficient utilization of reactor time. Thus, the durations of reactor tests already are minimal; i.e., they do not last longer than is necessary to complete the test program. Consequently, reductions in scope or magnitude of testing programs are not a feasible way to reduce waste generation rates.

Another alternative is to curtail reactor operations, and thus airborne releases, whenever climatological conditions are not favorable for good atmospheric dispersion. Measures of this sort would not reduce the total quantity of radioactivity discharged to the environment, but possibly could decrease potential exposures to persons who may encounter the airborne plume because of greater atmospheric dispersion and dilution. Because exposures from present reactor releases are already extremely small, implementation of this type of alternative on a regular basis is not required.

b. Changes in Air Circulation Systems

A class of design changes that could be more practical for reducing airborne releases from existing INEL reactors involves modifications to the air circulation systems around the reactors. Some of the air or inert gas purging and cooling systems associated with the reactors could be eliminated or changed into a closed-recycle mode that would channel and accumulate the airborne wastes into a relatively small volume. At certain intervals, the relatively smaller volumes contaminated with higher concentrations of radioactivity could be treated to remove the radioactive products, thus largely eliminating the present airborne releases from the reactors. Changes of this type have not been costed for each INEL reactor but they are being evaluated to determine the feasibility of implementation.

c. New Air Filtration Systems

This class of alternatives involves collection, treatment, and packaging of the radioactivity for subsequent storage or disposal at INEL, or transport to an offsite location for storage. One method of removing the particulate radioactivity from the airborne waste streams is to provide filtration capable of removing particles from the air. State-of-the-art filtration methods, generally comprised of fiberglass-type prefilters followed by high efficiency particulate air (HEPA) filters, are capable of removing more than 99.9% of particles down to 0.3 μ in size. Air streams that are contaminated with particulates could be rerouted to existing filtration systems at INEL, or new filtering systems could be installed. Installation of HEPA filters on all contaminated gaseous waste streams at reactors would eliminate particulate releases from this source.

This alternative would mainly affect the reactor off-gas systems at TRA. Particulate filters have not been installed in these off-gas systems because the main releases from the reactors are the noble gas isotopes which cannot be removed by filtration. However, installation of filtration media would allow for the capture of particulate daughters of noble gases and also could provide final filtration capabilities in the event of accident situations. Table II-65 indicates that at a typical reactor facility (TRA) only 2 to 3% of the 47,000 Ci released are particulate, thus 97 to 99% of the curies would not be removed by filtration. Nevertheless, this particulate filtration alternative, if adopted, would stop the buildup of particulate contaminants (mainly cesium and rubidium) in the local environs. The filters would have to be checked periodically; and as the filters become loaded with dust and radioactive material, new ones would be installed. The cost to install HEPA filters on applicable TRA airborne effluent systems would be approximately $300,000.

The monitoring, handling, and packaging of these filters could result in radiation exposure to workers. Based upon experience, these exposures would be low (generally on the order of a few millirem) but would have a minor impact. There is also the impact of having to provide long-term confinement of the used filters. This would be accomplished within the existing system by transporting the packaged filter to the INEL radioactive solid waste disposal site for disposal. It should be noted that this alternative does provide the advantage of maintaining control of the radioactivity by capturing it in the filter, instead of releasing it to the atmosphere. Current assessments are that this modification would not be cost-effective.

d. Removal of Gaseous Products

To reduce significantly the amount of radioactivity in airborne waste streams at reactors requires installation of systems capable of stopping the release of gaseous products. Because these gases are inert, they remain suspended and are dispersed by atmospheric motions until they decay to stable nuclides. Removal of noble gases may be accomplished by use of absorbers such as activated charcoal which holds the noble gases and allows them to decay, by providing holdup tanks where gaseous streams can be contained until they have decayed, or by use of removal systems such as cryogenic separation schemes.

Half-lives of the radioactive gases range from fractions of seconds up to about 11 yr for krypton-85. Because of the half-lives involved, holdup tanks capable of receiving all gaseous waste streams released over a several day period are required to hold long enough for substantial decay of the short-lived radionuclides. Because of the large volumes involved, this alternative is impractical. Installation of absorbers such as activated charcoal or zeolite beds or cryogenic systems on a large scale is currently judged to be prohibitively expensive, costing around $1,000,000.

Present plans call for development of the alternative of reducing the contaminated gas volumes produced. This will be accomplished by elimination of purges over reactor vessels, then treating the small volumes of airborne waste by a combination of filtration, holdup, and removal. This method is considered to be the most efficient way of reducing releases of radioactive gases from reactor off-gas systems.

2. Alternatives for Radioactive Airborne Wastes from ICPP

The largest source of airborne contamination at INEL is the Idaho Chemical Processing Plant (ICPP). At ICPP irradiated nuclear reactor fuel is reprocessed to remove the fission products from the useful residual fuel; the resultant high-level liquid wastes are stored and eventually solidified for long-term storage.

a. Elimination of WCF Operations

A small fraction of airborne wastes at ICPP could be eliminated if the high-level liquid wastes were not solidified at WCF. Failure to solidify liquid wastes is not consistent with ERDA's goal of solidifying present inventories of liquid wastes to reduce their mobility and potential impact from leaking. Also, offsite transportation of high-level liquid wastes is not allowable under present regulations. Further, since operation of WCF contributes only a small portion (less than 1%) to the total ICPP airborne radioactive waste inventories released, changing the rates of solidification of liquid wastes would not reduce the overall environmental impact by any significant amount. Alternative solidification methods would release similar amounts of airborne waste, and would require commitment of additional resources. There is, therefore, no incentive for changing from WCF operations. Consequently, continued operation at WCF is the preferred alternative. An environmental statement has been prepared for installation of a new waste calcination facility at INEL. More detail concerning alternatives to WCF can be obtained from WASH-1531[37].

b. Improvements to ICPP Systems

Improvements to the systems for treating airborne radioactive wastes at ICPP in order to reduce release levels are reasonable alternatives to present operational systems. As described in Section II.A.3.a., an atmospheric protection system which provides double filtration of particulates has been installed at ICPP This system essentially eliminates airborne particulate waste releases from ICPP operations.

Other alternatives could provide for removal or decay of radioactive gases from waste streams. Systems for absorption of gases on activated charcoal or zeolite beds, and for cryogenic separation are being evaluated. Research on these and other methods is continuing; those methods that are most effective will be implemented to achieve additional reductions in radioactive gaseous effluents from ICPP.

During 1974, 254,000 Ci of krypton-85 were released from ICPP. This represents essentially 100% of the krypton-85 released to the atmosphere at INEL. Because of the nature of the nuclear decay of this isotope, the resultant radiation dose is low. The annual dose at the nearest site boundary from the 254,000 Ci release in 1974 was calculated to be 0.03 mrem. Doses at more distant locations were lower. Krypton-85 is inert and remains within the atmosphere. The environmental impact from krypton-85 would be eliminated by adoption of a removal system alternative. A krypton-85 cryogenic distillation gas collection system at ICPP would cost approximately $2.5 million. As a result of the collection and storage of these longer-lived isotopes some potential environmental impacts could occur. The storage vessel would have to be isolated and monitored over a long-term period.

3. Alternatives for Other Sources of Airborne Radioactive Wastes at INEL

Reactors and ICPP are the predominant sources of airborne radioactive wastes at the INEL. Research laboratories, hot cells, fuel examination facilities, and other support operations routinely circulate exhausts through the cleanup facilities provided for the reactors, at ICPP, or have integral HEPA filtration capability. Some operations, however, such as the handling of solid radioactive wastes at RWMC and the decontamination of facilities, do provide sources of airborne contamination that are potentially more difficult to control (as described in Section III.). These operations are regulated and controlled to ensure that operations proceed only when weather conditions (such as wind speeds) are favorable for minimization of operational risks and spread of contamination. Because contaminated facilities do exist at INEL, some potential exists for airborne activity during cleanup operations. All reasonable precautions to minimize the spread of contamination are factored into the planning of these operations.

C. ALTERNATIVES FOR NONRADIOACTIVE AIRBORNE WASTES

Nonradioactive particulate and chemical air pollutants are generated in some INEL operations. Because of the remoteness and low population density of INEL, the impact from these nonradioactive sources is presently negligible. However, alternatives to generation or release and alternate treatments of these wastes are presented.

1. Alternatives for Current Space Heating Systems

Combustion products from burning fossil fuels for space heating at INEL are a principal source of air pollution. The major identified undesirable components of the nonradioactive airborne wastes from space heating are sulfur dioxide particulates, and No_x which ensues from burning low-quality fuel oil. The alternatives are:

(a) Convert to electrical space heating

(b) Lower the temperatures in the buildings being heated to reduce amounts burned

(c) Use higher quality low sulfur content fuel oil

(d) Burn coal

(e) Provide solar heat.

Switching to electric heating would only transfer the environmental impact to another location where fossil fuels would have to be burned to generate electricity. Increased hydroelectrical generating capacity in the region is not readily available except by innovative approaches such as low head turbines. Such selections can be expected to be made without reference to INEL practice, with incremental capacity going to oil. Additional impacts would arise from construction of more transmission lines and distribution systems. The temperatures in federal facilities already are kept as low as is judged compatible with effective performance of personnel and equipment. Higher quality low sulfur content oil is considerably more expensive the oil now being used and should be conserved for more efficient uses. Burning of coal would require new furnaces and could increase sulfur dioxide releases unless expensive "scrubbers" are added to remove sulfur. Continued use of low quality fuel oil, therefore, is the most reasonable short-term alternative at INEL, since there is now no impact from this source. All new facilities and renovations at INEL now require an assessment of alternative energy sources and their respective impacts. Should alternate space heating methods become more feasible, e.g., solar heat, they will be implemented.

2. Alternatives for Reducing Releases of Nitrogen Oxides from WCF

When high-level radioactive liquid wastes are solidified in the waste calciner at ICPP, nitrogen oxides are produced by thermal decomposition of nitric acid and metal nitrates. Although ground level concentrations of nitrogen oxides presently are well within established guidelines, the following alternatives to reduce the contaminants to even lower levels were considered.

The 1,000 to 2,000 kg (2,200 to 4,400 lb) of nitrogen oxides that are released daily to the atmosphere during operation of WCF could be eliminated by ceasing operations of the waste calciner. Implementation of this alternative would result in a growing accumulation of high-level liquid waste, and would not be compatible with ERDA's goal of solidification of liquid wastes. Additional liquid storage tanks would have to be constructed to provide storage capacity for the accumulating high-level liquid waste. Alternative solidification methods include other calcination methods, evaporation techniques, and addition of drying agents like cement. (These other solidification methods are discussed in paragraph D.2. in more detail.) In general, similar types of airborne waste would be generated for processes involving heating the liquids, and addition of drying agents creates large volumes of solid waste. Operation of WCF is adequate to prevent accumulation of liquid waste.

Another approach is to treat the calciner off-gas to remove the nitrogen oxides before they are discharged to the environment. Although the technology for this process has not been demonstrated, a conceptual plan for removal of nitrogen oxides from the off-gas has been formulated. The plan consists of removing nitrogen oxides by catalytic reduction with gaseous ammonia in a fixed bed of zeolite. During the process, the nitrogen oxides and ammonia are converted to nitrogen and water. The estimated cost of such a system is $450,000. The decision to install such a system will be based on continuing measurements of nitrogen oxide concentrations and impacts. Implementation of this alternative essentially would eliminate the present releases of nitrogen oxides to the atmosphere.

3. Alternatives for Lessening of Nonradioactive Airborne Wastes from Other Sources

Vehicle exhausts, fumes from asphalt batch plants, dust from gravel pit operations, and construction activities contribute to air pollution at INEL. Open burning of solid wastes is discussed in paragraph G. The use of a bus fleet instead of individual cars for transporting personnel to INEL aids in keeping air pollution levels within acceptable limits. The air quality continues to be excellent because of the remoteness of INEL and the low population concentrations. No feasible alternatives have been identified that can eliminate completely these sources of airborne wastes.

D. ALTERNATIVES FOR RADIOACTIVE LIQUID WASTES

Table V-2 summarizes the sources of radioactive liquid wastes at INEL for 1974.

1. Alternatives for Radioactive Liquid Wastes from INEL Reactors

The majority of the nuclear reactors at INEL use water for cooling the core. The water entrains activation and fission products. small quantities of dissolved cladding materials, and other particulate and dissolved materials from valves, piping, and vessel walls as it circulates through the primary coolant system. The radioactive wastes in the coolant liquids are of concern in maintaining safe and environmentally acceptable reactor operations. The alternatives to the current methods for treating, handling, and disposal of the liquid wastes include procedural and technological concepts.

a. Recirculation of Coolants

Reducing the volumes of liquid waste produced in reactors is a practical approach that involves recirculation of the coolant liquid through the core. This system is already in use on some of the INEL

TABLE V-2

LIQUID RADIOACTIVE WASTE SUMMARY FOR 1974[a]

Facility	Volume (Gallons)	Volume %	Radioactivity (Curies)	Radioactivity %
ANL	9.7(4)[b]	<1	<1	<1
CFA	3.1(7)	5	<1	<1
CPP	3.8(8)	57	458	20
NRF	4.4(5)	<1	2	<1
PBF	4.7(4)	<1	<1	<1
TAN	1.3(7)	2	2	<1
TRA	2.5(8)	36	1,786	79
Totals	6.8(8)	100	2,248	100

[a] Data from IDO-10054(74) RWMIS 1974 Summary

[b] $9.7(4) = 9.7 \times 10^4$

reactors. Recirculation of the same liquid, however, does cause accumulation of higher amounts of radioactivity per unit volume of coolant. A potential problem inherent in this alternative is the possibility of contaminating the secondary coolant streams through leaks in heat exchangers. There is the possibility, then, that recirculation could result in large volumes of slightly contaminated liquids. To combat these problems, alternatives that entail removal of the entrained radioactivity from the recirculating coolant are required. Complete recycle of all liquids within a reactor cooling system will eliminate liquid waste releases, but will require application of more extensive treatment methods. Complete recycle of liquids, with no release of contaminated fluids, is a goal at all major INEL reactors.

A three phase program is presently underway at TRA which will essentially eliminate low-level liquid waste discharges to the environment. Phase 1 is a sampling and segregation program to identify and reroute contributing waste effluent streams. Phase 2 is a recycle project which will drastically reduce the amount and radioactivity level of liquid waste effluents. Phase 3 of the program will essentially eliminate liquid radioactive waste discharges from this facility. This program is scheduled for completion by about 1984.

b. Removal of Radioactivity from Liquids

The alternatives for treating liquids at reactors to remove the radioactivity include holdup for decay, filtration, chemical precipitation or flocculation, demineralization, and evaporation methods. Holdup tanks will allow the shorter-half-lived products to decay. The use of holdup tanks will reduce the total radioactivity in the liquids, but will not be effective for waste products with longer half-lives, which are of greater environmental concern.

Increased use of filtration will remove the larger suspended waste products; but providing more efficient and larger filters is expensive, requires cleaning of the filter media, and does not remove dissolved radioactivity. Filtration is being used at cleanup facilities as a pretreatment step to demineralizers.

A precipitation or flocculation system commonly is used to control chemical contaminants prior to sending the waste to a demineralizer system. At TRA, such a system could be used as a chemical treatment system prior to directing the liquid waste to a demineralizer system. The use of a precipitation or flocculation system at the LOFT reactor would cost $1.1 million and would result in a 50- to 100-Ci/yr reduction of radionuclides in liquid waste.

A demineralizer system which employs chemical attachments of radioactive ions on a resin is capable of removing most residual radioactivity from the liquid. Once the ion-exchange capacity of the resin is reached, the resin must be replaced. The saturated resin must be prepared for disposal, or be regenerated for reuse through chemical treatment. The discharged radioactive wastes must be contained and prepared for disposal. Different resins can be used serially to remove selectively individual contaminants from the liquids. All water-cooled reactors at INEL now use demineralized water. Additional demineralizers could be provided to increase the volumes of liquids that can be treated. An additional demineralizer system at TRA would cost $900,000 and would collect approximately 200 Ci of the 1,800 Ci now being routed to the seepage ponds per year. A similar system at the LOFT reactor would cost $700,000 and would result in a 50- to 100-Ci/yr reduction in radioactivity that is postulated to be released from this facility. Thus, a 300-Ci/yr reduction (out of approximately 2000 Ci) could be achieved for a $1.6 million cost.

A forced evaporation system normally is used for boiling off a portion of the liquid wastes which have a high solid or chemical content. The technique is not effective in concentrating isotopes which are highly volatile (e.g., tritium, iodine). There are several types of evaporator systems, such as coil or pot-type evaporators, vapor compression systems, natural circulation systems, and wiped-film evaporation systems. This alternative could be applied to the LOFT operation at a cost of $400,000 which could result in a 50- to 100-Ci/yr reduction of short-lived nuclides that otherwise would be released to a seepage pond. The main disadvantage of forced evaporation systems is the required consumption of energy to drive off the liquids.

The INEL operations produce tritium, which is a large contributor to the curies released. For example, at TRA 234 Ci of tritium were released in 246 million gallons of low-level liquid waste in 1974. The concentration and removal of tritium from liquid discharge at INEL is economically prohibitive, although the medium of discharge (shallow groundwater, aquifer, or atmosphere) can be varied by changing disposal methods, dilution factors, and evaporation rates. No treatment methods are economically practical to prevent the release of tritium. Whether it is released to the atmosphere, disposal pond, or aquifer does affect the resultant population dose, however. In the aquifer, the movement of tritium is closely monitored and tritium poses no risk to offsite populations.

c. Installation of Alternative Disposal Systems

At present, most INEL reactors discharge liquid wastes to unlined disposal ponds where seepage and evaporation reduce the volume of contaminated liquids. The evaporation from INEL ponds is estimated to be approximately 5 to 10% of the volume discharged, the rest seeps into the ground. One alternative to this type of disposal includes discharge of wastes to disposal wells that terminate above, in, or below the regional aquifer or that are drilled in areas that are not above a water table. However, ERDA has established a policy of not discharging to the biosphere liquids that contain radioactivity in excess of accepted permissible concentrations. The construction of new disposal wells is not in harmony with this objective.

A viable alternative to seepage pond discharge is the use of lined ponds. A lined surface pond would prevent the release of radionuclides to soils underneath the pond and hence to the aquifer. A lined pond would allow only natural evaporation to reduce liquid volumes. A percentage of the tritium in the liquid waste would evaporate and enter the atmosphere in the form of tritiated water. In 1974, about 6,000 Ci of tritium were released to the atmosphere from INEL gaseous waste systems. The dose from exposure to this tritium at the nearest site boundary is 0.09 mrem. If all of the approximately 250 Ci of tritium from TRA that are released annually to the pond were to enter the atmosphere, the tritium exposure would be increased by less than 10% or 0.009 mrem at the nearest site boundary, and no tritium would be added to that in the aquifer. Land commitment would be increased over that for an unlined pond, as evaporation would become the only mechanism for removal of liquids. A lined pond to serve the needs of TRA would require approximately 400 to 500 acres and cost more than $500,000. A pond of this size would create some negative impacts; it would attract waterfowl, and attempts to provide a covering for the pond would be economically impractical. Also, there would be increased expenses to fence the perimeter of the pond to exclude larger animals. On the positive side, however, the radioactivity collected on the pond liner would be available for recovery when the useful life of the pond was over; or, the pond could be backfilled to provide permanent storage.

TRA, TAN, ANL, and LOFT all use unlined ponds for release of liquid waste. The TRA pond received 1,800 Ci in 1974. Each of the remaining ponds accepts 10 Ci or less each year. Therefore, alternatives to modifying existing ponds relate almost exclusively to the TRA pond, which presently covers about 6 acres. The existing pond could be enlarged to provide added evaporation capabilities, reducing the downward movement of water (and contaminants) toward the aquifer. During 1974, 240 Ci of tritium, 41 Ci of sodium-24, 3 Ci of strontium-90, 3 Ci of cesium-137, and 1,344 Ci of chromium-51 were released to the pond (from TRA). In 25 yr of operation, tritium is the only isotope that has migrated to the aquifer from the TRA pond. By ion-exchange mechanisms, the remaining isotopes are retained in the soil underlying the pond, with the exception of the small amounts of tritium that evaporate.

2. Alternatives for Radioactive Liquid Wastes from ICPP

Radioactive liquid wastes are generated at ICPP from handling and processing of irradiated reactor fuel. The liquid wastes can be classified as high-, intermediate-, or low-level, depending on the amount of activity they contain. High-level wastes orginate in the first cycle dissolution and extraction of irradiated fuel. Low-level wastes are generated in fuel storage areas, laboratories, and when small amounts of high-level wastes are diluted by further processing. Low-level liquid wastes from ICPP contain small enough quantities of radioactivity to allow discharge of the wastes to a disposal well. Intermediate-level wastes contain greater than low-level quantities of radioactivity.

Presently, high-level liquid wastes are stored in stainless steel tanks contained in underground vaults; these wastes then are channelled to WCF, where they are processed to solid form by means of calcination. Low-level wastes are disposed of via a disposal well. The intermediate-level wastes are either evaporated or calcined with high-level wastes.

a. Curtailment of Operations

Most of the fuels reprocessed at ICPP are highly enriched in fissile nuclides. Reprocessing of the enriched fuel elements is essential in order to recover the residual unconsumed fuel. A decision to forego recovery would be highly inefficient since approximately 80% of the usable fuel remains unconsumed. Therefore, a reduced scope of operations is not considered to be reasonable.

b. Recycling of Reprocessing Chemicals

The chemical processes by which fuels are reprocessed could possibly be changed to reduce slightly the volume of high-level liquid wastes produced. Additionally, recycling and recovery of chemical streams possibly may reduce the volume, but the same inventory of fission and activation products must be removed from the fuel.

c. Installation of Alternative Waste Treatment Techniques

Alternative treatment for the high-level liquid wastes includes the option of not solidifying the wastes. This option then would require storing the wastes indefinitely as liquids, or discharging them into the ground. Neither of these methods complies with current ERDA policies and guidelines. Further, since high-level liquid wastes cannot be shipped offsite for solidification at other facilities, some form of solidification at INEL is required.

Instead of calcination at WCF, other solidification methods could be considered. These would include alternate ways of calcination as well as other solidification methods, such as simple evaporation or addition of drying agents like cement.

Another example is the rotary kiln calcination concept, which involves slowly injecting concentrated liquid waste into a rotary ball-mill kiln where it is calcined into a powdery solid. This kind of process produces large amounts of contaminated dust which cannot be controlled adequately, and the maintenance of moving heavy equipment would be difficult and expensive. Also, the final product from the kiln would not provide any advantage over the present calcined product with regard to stability or leachability. Consequently, this approach is not a practical alternative to the presently used method, which is compatible with interim storage requirements. Final forms of the solidified waste suitable for disposal in the federal repository have not yet been selected. Calcination provides a product suitable as a feed stream for future processing.

The chemical makeup of the high-level liquid wastes at INEL favors the calcining method of solidification over evaporation processes, which produce salt cake. Fluidized bed calcination converts the high-level waste containing high concentrations of zirconium and aluminum from dissolution of fuel cladding to a dry, granular solid easily transportable by pneumatic means. The calcined product is also favored over a salt cake because of its better stability and leachability aspects. Solidification by addition of drying agents which absorb the liquids is possible. However, this process increases the total volume of waste and offers no advantages over calcination. The present method of fluidized bed calcination is the most practical method of solidifying the high-level wastes at ICPP.

Intermediate-level wastes at ICPP are solidified by evaporation or by calcination with high-level wastes. Alternative heat sources for evaporation could be considered, but would produce similar impacts and require additional commitments of resources. Continued use of the present evaporator remains to date the most feasible approach to treating intermediate-level liquid wastes at ICPP.

For the low-level liquid wastes at ICPP, operational alternatives appear to hold promise. Some low-level liquids will continue to be generated as long as the fuel reprocessing plant operates. Modifications in operations could reduce the volumes of these wastes produced by recycling the liquids, by segregation, or by improving the methods for removing the radioactivity from the water. These modifications, which would be similar to those discussed for treating radioactive liquid wastes from reactors, would include filtration, chemical precipitation and flocculation, and demineralization methods. Implementation of such alternatives could remove essentially all of the radioactivity from the liquids, except for the tritium. Evaporation schemes would volatilize some of the tritium and iodine, but would eliminate discharge of liquid wastes to the aquifer. Low-level wastes could be routed to WCF or evaporator for solidification; but, the large volumes and low solids content of the wastes would make solidification prohibitively expensive and would reduce the capacity for solidification of higher-level liquids.

d. Installation of Alternative Disposal Systems

Alternatives also exist for disposal of the low-level liquid wastes. Presently, ICPP is the only facility discharging radioactively contaminated waste to a well that penetrates directly to the Snake River Plain aquifer. An average of 300 million gallons/yr, containing an average of 350 Ci/yr, has been discharged to the well since 1952. During 1974, the total activity of 458 Ci discharged was composed of 455 Ci of tritium, less than 1 Ci of unidentified beta and gamma, and less than 1 Ci of strontium-90. Alternatives to this method of disposal are wells that do not discharge directly to the aquifer, unlined ponds, or lined ponds.

An alternative to discharging low-level radioactive liquid wastes directly to the aquifer is to dispose of the wastes into a shallow well. The depth to the Snake River Plain aquifer at ICPP is approximately 550 ft. A shallow well approximately 100 ft deep would provide some 400 ft of basalt and sedimentary layers between the point of discharge and the aquifer. Such a well would cost approximately $10,000. This system would provide a mechanism for removing radioactive particulate ions, such as strontium and cesium, as the liquid percolates downward. Tritium, however, would not be removed and eventually would enter the aquifer. Since tritium constitutes 90 to 99% of the radioactive contaminants in the low-level liquid waste stream at ICPP, this alternative does not appear to offer any significant advantages.

Another possibility is discharge of the low-level wastes through a cased well to a point beneath the aquifer. However, the thickness of the aquifer is not known, nor are vertical migration rates of the radionuclides well enough established to justify the large expense of drilling and casing a well to extend to the depths involved.

Some locations exist on or near INEL under which there is no aquifer. A disposal well could be drilled and wastes transported to such areas for disposal. This alternative would create a new contaminated perched water zone, however, and is not in harmony with current ERDA guidelines and policies. Additionally, the chances of accidents and leaks in transporting the liquids several miles to such sites make this choice unacceptable.

Lined or unlined surface disposal ponds could receive the liquid wastes. An unlined surface pond would result in the same general impact as a shallow well as discussed above. The 300 to 500 Ci/yr of tritium, however, that are now being discharged into the Snake River Plain aquifer would be dispersed by two routes; i.e., evaporation to the atmosphere and percolation through the soil to the aquifer. Radioactive particulate materials (less than 10 Ci/yr at ICPP) would be concentrated in the first few feet of soil below the bottom of the pond. There would be additional adverse impact of permanently committing 6 to 10 acres of land area for an unlined pond, at a cost of about $500,000. If the pond were not covered or fenced, waterfowl and animals would have access to the contaminated waste water, which is unacceptable environmentally. The main positive aspects are that at the end of the pond's useful life, those isotopes remaining near the surface of the empty pond could be recovered using earthmoving equipment, or the pond could be backfilled to provide permanent storage. However, seepage ponds are not in keeping with current ERDA policies and guidelines.

Lined ponds allow evaporation of the liquids, leaving the residual radioactivity in the pond. The requirements and impacts of this alternative are similar to those previously discussed for radioactive liquid wastes from INEL reactors. The large areas required, high costs, and volatilization of tritium make this alternative undesirable.

At ICPP, methods are implemented as they become practically available for removing radioactivity from liquid wastes streams. Operations at ICPP are being conducted under this philosophy, since it is a most obvious as well as reasonable alternative available for implementation.

3. Alternatives for Radioactive Liquid Wastes from Other Sources at INEL

Sources of radioactive liquid wastes other than the reactors and ICPP include laboratory operations, decontamination efforts, radioactive clothing laundry effluents, and other miscellaneous operations. Such low-level wastes could be routed to the liquid waste cleanup systems installed for the reactors or ICPP. The low-level waste, however, can be released without environmental impact.

E. ALTERNATIVES FOR NONRADIOACTIVE LIQUID WASTES

Two main sources of nonradioactive liquid wastes from INEL facilities are chemical waste from regeneration of demineralizers (water softeners), and cooling water. The highly concentrated chemical, low-volume liquid wastes from regeneration of demineralizers presently are discharged to surface disposal ponds at INEL facilities. The high-volume, low-concentration water treatment wastes and cooling water from ICPP and TRA are discharged through wells to the Snake River Plain aquifer.

The alternatives available for removal and collection of chemicals and minerals from regeneration of ion-exchange columns are the same as those described for radioactive liquid wastes. These methods include installation of additional demineralizer systems, installation of evaporation systems, and implementation of alternate discharge methods. Implementation of these alternative methods and systems would not be practicable for the high volume, low chemical concentration wastes presently routed to disposal wells at TRA and ICPP. However, capture of chemicals in highly concentrated, low volume liquid wastes could be increased by using one or more of the above methods. In this case, alternate methods of disposal of the collected waste would have to be considered. Presently, this kind of waste is routed to small diked unlined ponds. Weighing the advantages and disadvantages, the collection and concentration of the waste does not offer an advantage over the present method of disposal of nonradioactive chemical and liquid wastes.

There are alternative methods of disposal for the low-level chemical wastes at TRA and ICPP. At TRA, cooling water blowdown contains naturally occurring dissolved solids and corrosion inhibiting chemicals. ICPP waste water contains water treatment wastes consisting of naturally occurring dissolved solids and treatment chemicals. The effects of these discharges to the Snake River Plain aquifer have been studied in Section III. The chemical concentrations of liquid waste discharges to the aquifer from ICPP and TRA are presently below the State of Idaho release standards at the point of discharge. Nevertheless, alternatives are available for these wastes. The alternatives, which are similar to those described for radioactive liquid wastes, include providing other methods of disposal, including disposal to a shallow well or surface pond (lined or unlined).

Disposal to a shallow well would allow the water to percolate through soils where ion-exchange would provide some additional removal of the low-level chemical contaminants prior to reaching the aquifer. This alternative would cost approximately $10,000.

Surface ponds, either lined or unlined, could be constructed to receive the low-level chemically contaminated wastes now being discharged to the aquifer from TRA and ICPP. An unlined pond would require up to 30 to 40 acres, and a lined pond would require a land commitment of up to 500 acres at each facility. The chemical contaminants would be collected in the soil underneath the unlined pond or on the liner of a lined pond. These chemicals could be recovered, or they could be buried at the end of the pond's useful life; thus providing permanent storage of the chemicals. A 500-acre lined pond is ecomically prohibitive. An unlined pond would cost approximately $500,000.

Sanitary wastes are handled by sewage treatment plants at the larger facilities, and by septic tanks and cess pools at the smaller installations. These waste treatment facilities have been sited carefully to preclude environmental problems.

Oil from vehicles and other industrial wastes are disposed of in keeping with State of Idaho guidelines and regulations. No contamination or other environmental problems have been observed from disposal of these wastes.

F. ALTERNATIVES FOR RADIOACTIVE SOLID WASTES

Table V-3 summarizes the sources of solid wastes at INEL for 1974.

TABLE V-3

SOLID RADIOACTIVE WASTE SUMMARY FOR 1974[a]

	Volume		Radioactivity	
Facility	(ft^3)	%	(Curies)	%
ANL	9,535	12	708	4
ARA	786	1	1	<1
CFA	7,706	10	16	<1
CPP	34,078	45	5,739	29
NRF	9,711	13	5,822	29
TAN	7,077	9	6,736	34
TRA	7,631	10	736	4
Totals	76,524	100	19,758	100

[a] Data from IDO-10054(74) RWMIS 1974 Summary

1. Alternatives to Generation or Release of Radioactive Solid Wastes from INEL Sources

Because of the existing radioactive solid waste management facilities at INEL, alternatives that preclude generation of solid radioactive wastes in the future will not eliminate the requirements for a continuing solid waste management operations program, nor totally remove the environmental impacts resultant from such operations. Nevertheless, such alternatives are considered to ensure that the environmental impacts from INEL operations remain within acceptable limits.

Radioactive solid wastes are generated at INEL from the reactor plants, ICPP, laboratories, and decontamination and cleanup efforts. Alternatives that reduce the volumes or amounts of radioactive solid waste produced from the ongoing operations are possible. However, converting the more mobile wastes to solid form is stressed, since solidification of high-level liquid wastes and of the residues from treatment of low-level liquids provides a stable and environmentally acceptable physical waste form. Procedures at INEL already dictate that minimum amounts of materials be utilized in operations involving radioactivity to ensure that the volume of solid wastes produced is minimal.

Instead of generating radioactive wastes that require disposal through cleanup efforts at contaminated facilities no longer in use, long-term surveillance could be provided and the facility left intact indefinitely. However, this alternative does not provide the public safety, minimum surveillance requirements, nor reuse of land and facilities that result from performing site decontamination and restoration activities. It also does not eliminate the requirements for continued surveillance at radioactive waste disposal sites where wastes from decontamination efforts already have been stored.

2. Alternatives to Receipt of Radioactive Solid Wastes at INEL from Offsite Sources

Wastes sent to INEL from offsite sources are generally intended for interim storage at TSA. These wastes contain transuranic nuclides in levels greater than 10 nCi/g of waste, and are generated in ERDA research and development efforts and national defense activities.

One alternative for these wastes is to discontinue the national defense and energy development programs that produce the radioactive wastes. Consideration of this alternative is not within the scope of this statement.

The wastes now arriving at INEL could be transported to alternate locations for interim storage pending development of a federal repository for final disposal of the wastes. Implementation of this alternative would require construction of a similar interim storage site with attendant similar environmental impacts. TSA still would require continued surveillance and maintenance until the federal repository was built. Because the wastes now stored at TSA would have to be transported to the repository and since TSA operations already are safe, efficient, and effective, there are no incentives for construction of a new interim storage facility at any other site.

Offsite facilities responsible for generation of wastes are investigating alternatives that would reduce the volumes of wastes sent to INEL. These alternatives include physical compaction, incineration, and resource reclamation from wastes. These alternatives will reduce the volumes of wastes transported and stored, and will be incorporated as they become available.

Another alternative involves construction of a waste treatment plant at RWMC. This treatment facility would include provisions for volume reduction of wastes sent to RWMC for storage or disposal, as well as for any wastes recovered that are already buried. Alternatives for this type of facility will be addressed in future environmental statements written specifically for possible treatment and retrieval programs.

3. Alternatives to Storage of Radioactive Solid Wastes at INEL

Some radioactive solid wastes are stored at INEL (transuranic contaminated wastes at the TSA, and calcined high-level wastes at the WCF) as opposed to disposal by burial. At WCF, calcined solids are placed in interim 20 year storage in 500-year-integrity steel vessels inside concrete tanks. The present calcined waste storage facility includes provisions for retrieval as better storage sites or methods become available. In addition to solids being safer and easier to handle than liquids, calcination reduces the volume by a factor of ten. To date there has been no identifiable adverse environmental impact from storage of the solid calcine.

Storage alternatives for this solid waste include locating the tanks at other locations, storing the calcine product in different containers, and changing the form of the solid product. There are no advantages to relocating the tanks, as the present location provides adequate safety and environmental protection. The calcined product could be packaged in smaller containers and stored in newly engineered facilities. However, the high radiation levels require remote operations, which are more compatible with the present bulk handling system. Storage in large tanks is also less expensive than individual handling and packaging.

Leaving the waste in its present calcined state makes it readily available for future recovery and treatment alternatives. It is true, however, that the solidified high-level waste could be treated further to change its physical form. Glassification is one popular alternative. Such schemes are not alternatives to solidification via calcination, but are possible additional steps that could be taken to reduce the leachability of the wastes. Glassification would involve conversion of liquid waste and already calcined wastes to various types of glasses such as glass ceramics and devitrified phosphate glasses. Such glasses could provide long-term storage stability and leach resistance. The potential conversion of the present calcined waste to glass is being studied because of the longer stability and low leachability aspects. If judged as an acceptable further step in long-term waste conversion, appropriate facilities will be required. The final volume of glass, however, would be somewhat larger than the present calcined waste for an equivalent amount of liquid waste.

For transuranic wastes stored at TSA, alternatives include construction of engineered warehouse-type facilities for interim storage of containers of waste. Because TSA operations have proven to be safe, effective, and efficient for handling the wastes, there is no incentive to construct alternatives that would be considerably more expensive for interim storage.

A number of long-term waste management alternatives are available to ERDA in the management of high-level waste at INEL. Currently, ERDA is preparing a document, ERDA-77-43, concerning alternatives for long-term management of defense high-level waste at INEL. The alternatives addressed in the document for disposition of ICPP high-level waste are:

(1) Retain the waste at the ICPP in retrievable storage facilities

(2) Ship the waste to a Federal repository

(3) Remove the actinides (certain long-lived radioactive nuclides) from the waste; ship the actinides to a Federal repository and store the remaining waste containing the fission and activation products at the ICPP

Waste forms being considered in the document for the calcine are:

(1) Calcine pelletization, representative of pellets, calcine, and stabilized calcine

(2) Metal matrix, representative of metal and concrete matrix forms

(3) Sintered glass-ceramic (SGC), representative of glass, sintered glass, and sintered glass-ceramics.

The final alternatives document will describe technology required for treating the waste, the risk to the public, and preliminary cost estimates. The document presents information on the aspects of alternatives and serves as a basis for discussions and judgment in future decision making. No recommendation for implementation of any alternative is made. Comments will be taken into account in the preparation of a site programmatic environmental impact statement which will assess in detail all reasonable alternatives for long-term management of the ICPP defense high-level radioactive waste. When a program is selected, it will be conducted in accordance with all environmental, health, and safety requirements.

The alternatives document is being prepared for release in late 1977. Present schedules call for implementation of the chosen process during the 1980's and 1990's. Another 10 to 15 years then would be required to process the waste existing at that time and the additional waste generated during the reprocessing time. The present method for interim storage of the waste in the stainless steel bins within reinforced concrete vaults has been demonstrated to be safe until a resolution on the final method of disposal of the calcine can be made.

With respect to the transuranic waste stored at the RWMC, ERDA is conducting a study to identify reasonable alternatives for long-term management of the waste. The results of the study will identify costs and risks associated with each alternative and will form the technical basis for a site programmatic environmental impact statement assessing the environmental impact. The alternatives document will be prepared for release in late 1977.

4. Alternatives to Disposal Operacions at INEL

Solid wastes at INEL which do not contain significant quantities of transuranic activity are disposed of by burial in a landfill-type operation. Alternatives to this operation include the possibility of relocation of the burial site on or near INEL at a location not above the aquifer. However, to move the wastes now buried at the SL-1 Burial Ground and at RWMC would involve potential hazards to personnel, and would be extremely expensive. No migration of radioactivity to the aquifer has occurred from present solid waste disposal operations. Relocating the disposal site without moving presently disposed wastes is not advantageous because a surveillance program for solid waste already buried still would be required.

Alternatives for disposal also include changes in the disposal method. Lining of burial trenches with relatively impermeable materials could lessen the chances for migration of wastes downward. Engineered facilities could be built in which wastes could be stored. However, these alternatives are expensive, and would result in no reduction in environmental impacts from disposal operations, which are already very small. Volume reduction on solid wastes that are compactible is now being achieved by use of a bale-type compactor. Other alternative waste treatments include incineration. These methodologies are being studied, and will be implemented if they prove feasible for INEL operations.

G. ALTERNATIVES FOR NONRADIOACTIVE SOLID WASTES

The present mode of operations of the sanitary landfill used for disposal of nonradioactive solid waste at INEL is described in Section II, and the associated impact is given in Section III. During 1974, approximately 650 cubic yards per week of nonradioactive wastes were generated at INEL and disposed of at an abandoned gravel pit. Accepted sanitary landfill techniques were utilized. This was accomplished without identifiable adverse environmental impact. This operation is conducted at an annual cost of about $20,000. As discussed previously, alternatives involving elimination of activities producing wastes are not acceptable. The nonradioactive solid waste disposal program at INEL can continue as at present without adverse environmental impacts. Alternatives are available, however.

One possible alternative is utilization of a county-operated landfill. This alternative can be employed for about $13,700 annually, but it does not offer the advantages of control, flexibility, convenience, and safety that are available with the INEL operation. The overall environmental impact would be perhaps greater because of the need for transportation of the wastes. In addition, the cost figures could increase due to added transportation costs associated with the current energy crisis.

Other alternatives involve incineration of the wastes. Open burning was previously used at INEL. In 1970 the State of Idaho passed a law prohibiting open burning, and ERDA responded by issuing a corresponding Immediate Action Directive in November of the same year. Consequently, from an environmental standpoint, open burning is not considered a viable alternative. Thermal incineration in engineered systems was also considered. If properly designed, this type of system could preclude any significant insult to the environment. The cost of this alternative would be approximately $34,000 annually.

A final alternative considered would be to dispose of the nonradioactive solid waste by composting. Since no significant adverse environmental impact is identified with the present system, this alternative was not investigated further than to estimate the cost at $68,000 annually.

VI. RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The release of waste products into the environment may have effects which are of short- or long-term duration, depending on the definition of the relative terms "short" and "long." For the purpose of this document, these terms are used within the concept of the human lifespan where 10 yr, or less, is considered short-term and more than 100 yr is long-term — with the intervening period a matter of individual interpretation.

A. AIRBORNE WASTES

The effects of short-lived isotopes of the noble gases such as argon-41 (1.8 hr), krypton-88 (2.8 hr), or xenon-138 (14.2 min) will be of short duration; for example, the radioactivity remaining after 18 hr as a result of argon-41 will be 0.001 of the initial amount. Radioactivity decay and dispersion result in reducing the hazard potential from short-lived nuclides to a point of inconsequence. Calculations show that the contribution of all INEL airborne effluents is 0.2% of the total background radiation dose at the laboratory boundary, which is 150 mrem/yr.

The relatively slow attenuation of activity resulting from krypton-85 (10.7 yr half-life) plus the characteristic of being inert and not subject to atmospheric reactions, results in a minor contribution to the long-term worldwide burden.

Contamination of land due to fallout of radioactive particulate waste has been detected near airborne release points at INEL. The levels are not considered sufficient to prohibit continuing use of the land for any purpose. However, use of the land for purposes other than those for which it presently is being used is not foreseen in the short term. Over the long term, decay will continue to attenuate this radioactivity.

B. LIQUID WASTES

The long-term effects on the lithosphere occur as a result of contami-nated liquid discharges to seepage ponds, resulting in a contaminated soil column. In the case of radioactivity the contributing nuclides are strontium-90 and cesium-137 (28- and 30-yr half-lives, respectively). The land commitment involves a time period in excess of 100 yr. It has been postulated that ponds can be backfilled and used for other purposes such as surface construction or even agriculture. Such uses are not contemplated or necessary. Future needs for space or land are a matter of conjecture, but at the present time, the pond areas of about 52 acres are considered committed for a long period of time.

Land contaminated by disposal of liquids containing nonradioactive chemicals will be compromised for agricultural uses over a short or intermediate term, but it can be reclaimed over a long period if required.

The disposal of liquid wastes to the aquifer, either radioactive or nonradioactive, does not preclude the use of this resource at any location. Monitoring confirms the concentrations of contaminants as being localized and below those allowed by existing quality standards. Long-term sampling will be required to monitor the aquifer to ensure that existing or future concentration standards are not exceeded. Since the aquifer is a dynamic system, radioactive decay and dispersion reduces concentrations to levels below detectable values within distances of less than 15 mi from the point of release.

C. SOLID WASTES

The use of land on which solid radioactively contaminated waste is buried or stored is a long-term commitment. Even if the stored wastes were to be recovered and moved elsewhere, the time required would be longer than 10 yr, and residual radioactivity would preclude use of the land for other purposes. The total land area involved is at present about 158 acres. At the present time, there is no basis for assuming that the size of the area used for disposal of solid waste will increase.

The use of about 25 acres for a sanitary landfill for nonradioactive wastes involves a commitment period longer than 10 yr. Biological decomposition of the waste will require long time periods. Such areas have been used as parks, construction sites, and for other uses; however, the presence of the covered waste presents a long-term nuisance impact, or limit, on land use that otherwise would not have existed.

VII. RELATIONSHIP OF WASTE MANAGEMENT TO LAND USE, POLICIES, AND CONTROLS

A. CONFORMANCE OR CONFLICT WITH LAND USE PLANS

There are no known conflicts with national, state, or local land use plans and programs in the continued operation of the INEL waste management facilities. An original portion of INEL was withdrawn from the public domain in the early 1940s by the U. S. Navy and later transferred to the AEC (ERDA). The present INEL land size was completed with the withdrawal of peripheral land in 1958. INEL occupies parts of five Idaho counties. The largest or major portion is in Butte County with a smaller area in Jefferson County and relatively minor areas in Bingham, Clark, and Bonneville Counties.

Land use planning to date has been primarily limited to the more densely populated areas; however, public interest is increasing and supplemental legislation is anticipated. Idaho is primarily an agricultural and lumber-oriented state, and in most of the counties there are large areas owned by the federal government which are used for grazing. ERDA's policies have not conflicted with these policies. INEL is predominantly dry and barren, and portions have been used unsuccessfully for dry farming. The land areas dedicated exclusively to waste operations represent about 0.04% of the total INEL area, and grazing is permitted on about 47% of the remainder.

With respect to long-range possibilities, the use of Idaho water resources is under study. An "Interim State Water Plan" has been developed in which land within INEL is classified according to potential for irrigation[115]. Table VII-1 shows the potentially irrigable area. Various quantitative estimates have been made of the groundwater below INEL[76]. One such estimate indicates a flow of about 2,000 ft^3/sec beneath INEL[116]. This would be equivalent to about 600,000 acre-ft during a 150-day irrigation season or 3 acre-ft for 200,000 acres, which is theoretically adequate. On this basis, irrigation of 30 or 35% of INEL is a hypothetical possibility. Areas dedicated to waste management would occupy about 0.1% of the potentially irrigable land. Past and postulated future waste disposal operations have not indicated any significant effect on water quality for this purpose.

There are no plans at the present time to irrigate any INEL land. Any use change is limited by federal ownership, which presently prohibits entry or reclamation. Future use is dependent upon such factors as population growth and food needs and also government policy with respect to resource commitment.

In late 1974, proposals were under advisement to designate INEL a National Environmental Research Park. In January 1975, INEL was established officially as the second National Environmental Research Park. The nation's first research park is located at Savannah River Operations in South Carolina. The designation of INEL as a National Environmental Research Park will encourage its use by scientists, universities, and

TABLE VII-1

POTENTIALLY IRRIGABLE LANDS WITHIN INEL

(Acres by County)

County	Class 1[a]	Class 2[b]	Class 3[c]
Butte	35,550	79,500	82,500
Bingham	6,250	22,300	10,700
Jefferson	4,100	63,500	26,100
Clark	0	800	10,300
Total (Acres)	43,900	166,100	129,600

Total (acres, all classes) 339,662

[a] Class 1 - Slight limitation; gravity-type irrigation feasible.

[b] Class 2 - Moderate limitation; gravity-type irrigation feasible.

[c] Class 3 - Severe limitation; limited potential sprinkler necessary.

private foundations for various short- and long-term ecological studies; and, it will permit the planning of long-term experiments necessary to evaluate, systematically and quantitatively, the environmental impact of nuclear operations, grazing, and other activities in the area. Among the stated objectives for the Idaho park are:

(1) To preserve the area as representative of a cooled-temperate, desert scrub biome

(2) To develop a regional reference "encyclopedia" on that type of ecosystem

(3) To provide training and educational opportunities for environmental scientists

(4) To develop ecosystem models which can predict, in advance, the effect of proposed activities in that ecosystem

(5) To continue the study of the behavior and effects of pollutants on the environment

(6) To study the effect of activities used to control predators such as coyotes and eagles.

B. COORDINATION WITH OTHER STATE OR FEDERAL AGENCIES

The subject of waste discharges has been a matter of interest and concern on the part of a number of government agencies, including the Idaho Department of Water Resources. A monthly summary of waste discharges at INEL is forwarded to the Governor of Idaho for distribution to interested state agencies. There are also Idaho laws[117] with respect to water quality standards[118]. Liaison with state agencies will be maintained to keep them informed of INEL operations and to resolve any differences that may arise with water quality standards.

VIII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

A. LAND COMMITMENT

The land area of INEL which has been or presently is being used for radioactive liquid seepage ponds and solid waste disposal storage comprises about 210 acres. These lands are presently considered to be committed for the foreseeable future.

B. WATER COMMITMENT

Approximately 2 billion gallons of water are pumped annually from the Snake River Plain aquifer to supply the needs of INEL operations. About one-half of this water is returned to the aquifer by direct discharge or percolation through the ground. The remainder is returned to the environment by evaporation and introduced into the natural water recycle chain. The amount consumed represents about 0.2% of the flow under INEL and less than 0.1% of the aquifer discharge.

C. ENERGY COMMITMENT

Electrical energy is the primary source of power utilized in the operation of the pumps and fans associated with the radioactive liquid and airborne effluent waste systems. Petroleum fuels are utilized for high-level radioactive liquid calcining, for transport of solid wastes to disposal storage sites, and for handling of solid waste at the INEL Radioactive Waste Management Complex. The electrical energy expended for the effluent system pump and fan motors is not metered separately and hence is not separated from the total plant electric power; however, the power consumption by these systems is only a small fraction of the total power used at INEL.

Although the fuel consumption of solid waste disposal handling equipment and solid waste transport units is not tabulated separately, the fuel used to transport solid waste is estimated to be 7,000 gallons of gasoline/yr. A total of 52,000 gallons of kerosene was used for high-level radioactive calcining during 1974.

D. MATERIALS COMMITMENT

The materials and equipment resources such as pumps, fans, tanks, piping, etc., used in the construction of the initial waste effluent systems are for the most part irreversibly and irretrievably committed resources. The quantity and type of materials committed as part of the initial installations have not been estimated, but the following ongoing committed material resources were identified:

(1) Approximately 89,000 ft^3 of concrete is used in the construction of the vaults used to house the metal bins (tanks) employed for the storage of the solid calcined waste

(2) During 1974, the following containers were used for solid radioactive waste materials disposed or storage at the INEL Waste Management Complex:

   (a) 2,300 cardboard boxes
   (b) 550 wood boxes
   (c) 12,000 metal barrels.

E. SOCIOLOGICAL COMMITMENT

The waste already existing at INEL, plus the waste to be generated in the future, will require surveillance for the foreseeable future. For most forms of permanent storage currently being considered, some form of surveillance is necessary. It is recognized that a precondition of successful surveillance is a stable social structure enduring throughout the storage period of the waste.

IX. COST-BENEFIT ANALYSIS

A. APPROACH TO ANALYSIS

This cost-benefit analysis is concerned only with the future costs and environmental impacts of the INEL waste management operations. Integral to the analysis is the application of technology that will reduce releases of nuclear and industrial wastes from INEL facilities to practicable levels that are even less than those already achieved. Although alternate waste systems are evaluated on a cost-benefit basis to determine the most practical approach of reducing the environmental impact from these wastes, it should be noted that the impact is already small and in most cases well below applicable guidelines. The continuing approach is to reduce discharges to as low as economically practicable as set forth by ERDA policy.

B. EVALUATION OF BENEFITS FOR THE WASTE MANAGEMENT OPERATIONS

1. Minimum Radiation Dose

The current annual radiation dose to the general population living in a 50-mi radius of INEL is estimated to be about 1.2 man-rem. This dose is low compared with the naturally occurring background dose of approximately 16,000 man-rem to the population living within 50-mi of INEL.

The maximum whole body dose received by an individual at the INEL boundary from INEL operations during 1976 was calculated to be about 0.2 mrem. This maximum individual dose is also low when compared with the naturally occurring background dose to individuals of about 150 mrem/yr in the Upper Snake River Plain.

No attempt has been made to estimate the reduction in radiation dose to the general public that has resulted from having the present waste management operations program. The alternative of not having some program for managing waste which has already been generated has always been considered an unrealistic case.

2. Minimum Chemical Pollution

The costs to the environment caused by chemical wastes produced at INEL are being minimized by the waste management programs with the net costs being minimal in terms of damage to the biota. Pollution from chemicals and from other solid wastes is minimized by storing the wastes or by releasing the chemicals to controlled disposal sites.

3. Increased Technical Knowledge

Research and development efforts are providing improved methods for handling radioactive waste and for extending knowledge of the effects of radionuclides on biota. For example, the world's first high-level liquid waste solidification (calcination) process was developed and demonstrated at INEL; consequently, this technology now is available to industry.

4. Employment

The total employment at INEL is approximately 6,000 persons. However, only 5-10% of the work force is directly or indirectly involved with the waste management portions of the total INEL operations.

C. EVALUATION OF COSTS FOR THE WASTE MANAGEMENT OPERATIONS

1. Capital Cost

The capital costs of the INEL plants and facilities exceed \$540 million. In most cases the waste management systems are included in total facility costs and are not identified separately. However, it is estimated that waste management systems represent about 5-10% of the total expenditure.

2. Operating Costs

The total operating cost of INEL is approximately \$100 million annually. Again, total waste management costs are difficult to identify because, in many cases, they represent a portion of a particular facility's operating cost. However, it is estimated that waste management operating costs would be less than \$10 million/yr for INEL.

3. Land Use

Continuation of the INEL waste management operations program will result in occupancy of land by structures containing radionuclides and restricted use of land containing radionuclides. The quantity of land committed (approximately 210 acres) will remain constant for about 300 yr because of the presence of Cs-137 and Sr-90 in burial grounds and seepage basins unless major recovery and cleanup programs are initiated. After 300 yr, the quantity of land required for such purposes will decrease to those lands (about 30 acres) containing plutonium or other long-lived transuranics. A summary description of the committed lands is presented in Table IX-1.

Commitment of some of the INEL lands to waste management makes that land unavailable for other uses. Because there are tens of thousands of acres of similar desert land available throughout the Western United States, the dedicated land cannot be considered to have rare characteristics that result in a premium value, such as for residential or industrial use. Ample similar land is available nearby for any such foreseen uses.

TABLE IX-1

DEDICATED WASTE MANAGEMENT LANDS

Description of Land		Approximate Area (acres)
Radioactive Waste Management Complex		
Subsurface Disposal Area		88
Transuranic Storage Area		58
SL-1 Burial Ground		4
ANL Radioactive Scrap and Waste Facility		5
ICPP Calcined Waste Storage Area		3
Seepage Basins/Evaporation Ponds		52
	Total	210

4. Planned Capital Investments[a]

Future construction costs for planned waste management facility improvement for FY-1975 through FY-1977 are estimated to be about $80,000,000 as outlined in Table IX-2.

D. COST-BENEFIT ANALYSIS

1. Planned Capital Investments

The planned and budgeted activities for FY-1975 through FY-1977 are summarized in Table IX-2. When implemented, these programs will provide additional safeguards in limiting the release of hazardous materials to the environment. The following benefits are expected from these planned capital investments.

a. RWMC Improvements

The proposed RWMC improvements ($2,900,000) will provide additional operating convenience, safeguards, and research information. The changes will improve radionuclide containment at a facility that already is contributing essentially zero population dose. The Air Support Building will provide all weather protection allowing year-round investigation of the feasibility of retrieval of previously buried plutonium wastes. The building will have appropriate contamination control barriers, thus avoiding possible spread of contaminants

[a] See Appendix E for improvements in waste management systems for 1975-76 and those projected beyond 1976.

TABLE IX-2

WASTE MANAGEMENT FACILITIES AND ACTIVITIES
PLANNED AND UNDER CONSTRUCTION
FY-1975 THROUGH FY-1977

Description	Cost
• Radioactive Waste Management Complex (RWMC)	$ 2,900,000
• Includes construction of the Early Waste Retrieval Air Support Building, a Waste Container Fabrication facility, an Intermediate Transuranic Waste facility, and an addition to the initial drum retrieval facility plus overall general improvements.	
• Idaho Chemical Processing Plant (ICPP)	
• New Waste Calciner	$65,000,000
• Calcined Solids Storage Facilities (Estimate for the fourth set of storage facilities)	$ 2,400,000
• Atmospheric Protection System	$ 3,400,000
• High-level liquid waste improvements include improved instrumentation, remote samples and monitors, a centralized data collection system, a monitoring and alarm system, encased waste line and a waste diversion pond.	$ 5,800,000
• Test Reactors Area (TRA)	
• TRA Liquid Radioactive Waste Upgrade (Phase 1)	$ 1,300,000
• Argonne National Laboratory - West	
• Reroute underground liquid waste line	$ 140,000

to the environment. The Waste Container Fabrication Facility will provide a testing facility to determine the most cost-effective container for repackaging retrieved plutonium wastes. The Intermediate Transuranic Waste Facility will provide a storage and handling facility for gamma contaminated plutonium wastes that will minimize direct radiation exposures to employees and provide an environmentally sound retrievable storage facility. The addition to the Initial Drum Retrieval Facility will provide long-term cost savings by minimizing the frequency of moving the Air Support Building.

b. Waste Calciner Facility

A new Waste Calciner Facility ($65,000,000) is proposed to allow higher throughput capacity as well as capability for processing future types of radioactive wastes. The existing facility, although successful, will be unable to achieve the required onstream time at the necessary throughput to solidify liquid wastes of the required annual rates. Major benefits of the new waste calciner are:

(1) A combination of direct and remote maintenance will significantly decrease radiation exposure to operating and maintenance personnel

(2) Increased reliability through simplicity in design and selection of construction materials compatible with existing and future wastes

(3) An improved dry and wet off-gas cleanup system will remove a greater fraction of solids prior to the off-gas filters

(4) Overall decrease in radioactive effluent releases to the environment resulting from improved process and equipment designs

(5) Improved waste transfer and leak detection capability.

c. Calcined Storage Bins

The calcined storage bins ($2,400,000) will provide additional capacity for storage of calcined wastes. The added capacity will allow continued solidification of existing and future high-level liquid wastes generated at ICPP. The bins are designed for retrieval of the calcined waste if retrieval becomes necessary. These bins allow the storage of wastes as solids instead of liquids which is a more environmentally sound method of storage.

d. Atmospheric Protection System

The Atmospheric Protection System ($3,400,000) provides high efficiency particulate filters in the ICPP off-gas. This system will eliminate essentially all particulate release from ICPP. The present 50-mi radius population exposure from this source is approximately 0.3 man-rem/yr. The Atmospheric Protection System will eliminate this exposure and provide filtration backup for any possible accidental releases in the plant.

e. High-Level Liquid Waste Improvement

The high-level liquid waste improvements ($5,800,000) will provide increased reliability and monitoring capabilities in the management of high-level liquid wastes. The general population exposure from this facility is essentially zero, and the proposed improvements will ensure this continued minimal impact.

f. TRA Radioactive Liquid Waste Management Program

The TRA radioactive liquid waste management program ($1,300,000) is devoted to reducing the amount of radioactivity discharged to the TRA seepage ponds. The pond is on a controlled area and the present environmental impact is limited to this area. The TRA facilities historically have released about 2,000 Ci/yr to the seepage ponds. The proposed upgrading will reduce significantly this amount with future goals of completely eliminating any discharge of radionuclides and providing a complete recycle system.

g. ANL Waste Line Rerouting

The ANL waste line rerouting ($140,000) consists of moving an underground liquid waste transfer line to the surface. Since the line is underground, any leakage cannot be monitored; therefore, the line is being moved to the surface to enhance monitoring capabilities. There is no environmental impact associated with this proposal but the change is being considered as a preventative measure.

2. Identified Alternatives

Section V has discussed a number of alternatives to, and possible improvements in, the present systems for handling and controlling wastes now released to the environment and impacting on it. In arriving at decisions on whether or not to implement some or all of these and to decide which might have higher priorities, cost-benefit analyses are necessary.

Ideally it is most useful to compare costs and benefits each expressed in common units (e.g., dollars). Although costs of effluent reductions are easily stated in dollars, the dollar value of benefits cannot easily be assessed. However, effluent reductions can often be expressed in such units as curies per year or millirem per year at the site boundary (without attempting to absolutely relate the reductions to benefits to man). Thus a cost-benefit ratio can be evaluated for each alternative and a listing of such ratios for all alternative improvement projects can provide comparisons between projects and permit assigning priorities based on the most cost-effective ratios. Estimates for curie per year reductions or millirem per year reductions are dependent on assumptions made with respect to system efficiencies, designs of systems, and other variables such as plant housekeeping and maintenance schedules. In Tables IX-3 and IX-4 cost-benefit ratios are presented for a large number of alternatives for handling airborne and liquid radioactive wastes. The data in these tables

TABLE IX-3

COST-BENEFIT ANALYSIS FOR INEL AIRBORNE WASTE HANDLING

Facility	1. Modification of Existing Systems				2. Installation of Particulate Filters				3. Installation of Adsorber System				4. Installation of Gas Delay System				5. Installation of Gas Collection and Storage Systems			
	Reduction Ci/yr and mR/yr	Capital Costs	Operating Costs per year	Cost/[a] Ci and mR Reduction	Reduction Ci/yr and mR/yr	Capital Costs	Operating Costs per year	Cost/[a] Ci and mR Reduction	Reduction Ci/yr and mR/yr	Capital Costs	Operating Costs per year	Cost/[a] Ci and mR Reduction	Reduction Ci/yr and mR/yr	Capital Costs	Operating Costs per year	Cost/[a] Ci and mR Reduction	Reduction Ci/yr and mR/yr	Capital Costs	Operating Costs per year	Cost/[a] Ci and mR Reduction
ANL-W Facilities																				
EBR-II		[b]				[b]				[c]			500Ci/yr < 0.1mR/yr (scheduled for operation in 1977) release may increase owing to change in test program.	$2,000,000	$25,000	$450/Ci >$2,250,000/mR >$1,500,000/man-rem	<0.001mR/yr <1 Ci/yr	$1,000,000	$25,000	>$125,000/Ci >$125,000,000/mR >$94,000,000/man-rem
Component Cleanup Facility	A new component cleanup facility has been constructed at a cost of $462,000. This reduces gaseous effluent release approximately 1 mCi/yr. The 0.9 mCi tritium will not be removed.					Included in facility design				[c]					[c]			[c]		
TREAT		[b]				[b]				[c]			149 Ci/yr <1 mR/yr	$2,000,000	$25,000	$1,510/Ci >$225,000/mR >$150,000/man-rem	0.14 Ci/yr <0.01 mR/yr	$1,000,000	$25,000	>$900,000/Ci >$12,000,000/mR >$9,000,000/man-rem
ZPPR		[b]				[b]				[c]			0.17 Ci/yr <0.1 mR/yr	$1,700,000	$20,000	$1,100,000/Ci >1,720,000/mR >1,150,000/man-rem		[c]		
HFEF		[b]				[b]				[c]				[c]				[c]		
Laboratory, office area, and support facilities	The radioactive gaseous release from this area has been <1 Ci/yr. Further treatment of the gas stream is not required.					[b]				[c]				[c]				[c]		
NRF	Owing to the low-release levels of the gaseous effluents from each of the NRF operating facilities, a cost-benefit study was not performed.																			
ICPP		[b]			The APS went in service in CY 1975 which prevents particulate releases.				<1 Ci/yr < 1 mR/yr (iodine removal)	$400,000	$10,000	> $50,000/Ci > $50,000/mR		[c] [c]			250,000 Ci/yr 0.03 mR/yr (krypton removal)	$2,500,000	$370,000	$2.5/Ci $21,000,000/mR $15,500,000/man-rem
LOFT	As this is a recently designed facility, system designs have been maximized for effluent control.			[b]		[b]				[b]			470,000 Ci short-lived low dose contributing noble gases. Still releases 250 Ci of krypton-85. <1 mR/yr	$192,000	$32,000	$0.10/Ci $51,200/mR $34,000 man-rem	Reduces 220 Ci krypton-85 over amount alternate 4 will reduce. <0.001	$1,000,000	$25,000	$500/Ci $125,000,000/mR $94,000,000/man-rem
PBF	As this is a recently designed facility, system designs have been maximized for effluent control.		[b]			[b]				[b]			290 Ci of argon-41 can be removed from effluent stream. 0.03 mR/yr	$350,000	$14,000	$169/Ci $1,600,000/mR $1,100,000/man-rem	[b] For experimental loop portion of system			
TRA	TRA has initiated controls using existing systems.	[b]			This includes installation of HEPA filters on all TRA gas released to stack. 600 Ci reduction. No significant measured offsite dose.	$285,000	$20,000	$80/Ci	This will remove iodine from the waste gas stream. Est. 0.2 Ci <.001 mR/yr	$110,000	$16,000	$135,000/Ci >$270,000/mR	Delay of effluents to allow for decay of 1.6-hr argon-41 ~ 2,000 Ci[e]. 0.1 mR/yr	$120,000	$20,000	$16/Ci $320,000/mR $230,000/man-rem	2 Ci (estimated) <.001 mR/yr	$1,000,000	$25,000	$62,500/Ci $125,000,000/mR $94,000,000 man-rem

[a] All waste system capital costs are amortized over 10 years although the facility may be designed for a 30-year life.

[b] Included in existing waste system design.

[c] Not applicable for this type facility or effluent stream

[d] Not technically feasible for this application.

[e] The argon-41 is released from three sources. It is only technically feasible to remove it from one of the low flow rate sources. This will remove ~ one-half of the radioactive release.

provide a comparative basis for possible future implementation of the various possible improvement programs.

a. Airborne Waste Systems

(1) Radioactive

Table IX-3 presents the cost-benefit analysis for the major INEL radioactive airborne waste systems. The alternatives listed in the table are specific examples of the alternatives listed in Section V.B. The reduction in effluent release is based on anticipated effluent treatment system operating efficiency coupled with the average measured or calculated contaminant release for each facility. As shown in Table IX-3, it would require large expenditures to achieve further reduction in the small environmental impact resulting from radioactive airborne effluents. In some cases, large expenditures can be justified based on protection against accidental releases, but for routine operations it does not appear cost-effective to provide additional filtration or holdup systems.

(2) Nonradioactive

The nonradioactive gases generated at INEL are mainly combustion byproducts. These are generated while producing process and space heat and during the operation of vehicles. There appear to be no significant adverse short- or long-term effects on the environment from the release of these effluents. The releases are minimized by fuel oil quality level when possible. Vehicles have been equipped with antipollution devices. A bus fleet is provided to reduce the numbers of vehicle miles required for transporting personnel to and from the site. Therefore, no viable alternatives nor cost benefits have been considered.

An additional source of nonradioactive gaseous effluents is the oxides of nitrogen which are released when waste is calcined at ICPP. Although plans have been formulated to reduce the nitrogen oxide emissions, the system cost of $450,000 is not warranted because the impact to the area is judged to be too small. The atmospheric concentrations from the released effluents are well below present guidelines.

b. Liquid Waste Systems

(1) Chemical and Radioactive

Since the methods for reducing releases to the environment from radioactivity or chemically contaminated waste streams are similar, the cost-benefit analysis is combined and presented in Table IX-4. The alternatives listed in the table relate to the categories of viable alternatives listed in Section V.D. Although the existing environmental impact from chemical and radioactive liquid waste is small (discussed in Section III) ERDA has established a policy that soil columns be phased

TABLE IX-4

COST-BENEFIT ANALYSIS FOR INEL LIQUID WASTE HANDLING[a]

Facility	1. Modification of Existing Systems				2. Discontinue Discharging to Deep Wells				3. Installation of Demineralizer System				4. Installation of Evaporator System				5. Installation of Precipitation or Floculation Facilities			
	Reduction Ci/yr	Capital Costs	Operating Costs per year	Cost/[b] Ci Reduction	Reduction Ci/yr	Capital Costs	Operating Costs per year	Cost/[b] Ci Reduction	Reduction Ci/yr	Capital Costs	Operating Costs per year	Cost/[b] Ci Reduction	Reduction Ci/yr	Capital Costs	Operating Costs per year	Cost/[b] Ci Reduction	Reduction Ci/yr	Capital Costs	Operating Costs per year	Cost/[b] Ci Reduction
ANL-W facilities																				
EBR-II	No liquid wastes are produced at EBR-II					[c]					[c]				[c]				[c]	
Component Cleanup Facility	A new component cleanup facility has been constructed at a cost of $365,000. This will reduce the liquid effluent release essentially to zero. Release now is 0.0024 Ci/yr.					[c]					[c]						Liquid waste will be transferred to evaporation facility.			
TREAT	No liquid wastes are produced at TREAT.					[c]					[c]				[c]				[c]	
ZPPR	No liquid wastes are produced at ZPPR.					[c]					[c]				[c]				[c]	
HFEF	The radioactive liquid waste from the HFEFs are transferred to the laboratory area for processing.					[c]					[c]				[c]				[c]	
L&O		[d]				[c]			A new radioactive waste treatment facility is planned for ANL-W. The new facility will provide evaporators, ion exchangers, and ventilation systems. The cost of the facility is $1,500,000 and is scheduled for operation in 1978.						[d]		Not required owing to construction of new waste treatment facility.			
NRF	Due to the low release levels of the liquid effluents from the NRF facilities, further reductions are not considered necessary.					[c]									[c]				[c]	
ICPP		[d]			450 Ci 750 tons	$500,000	$10,000	$130	10 Ci/yr addition of a second stage of ion exchange to existing system.	$25,000	$1,000	$350/Ci	Chemical contaminant removal from nonradioactive utilities waste. already present.					[c]		
LOFT	As this is a recently designed facility, the system designs have been maximized for effluent control. Anticipated liquid effluent contamination levels of liquid waste directed to seepage ponds will meet the drinking water standards[e].			[d]					50 to 100 Ci/yr	$680,000	$5,000	$730/Ci	50 to 100 Ci/yr	$400,000	$10,000,000	$100,400/Ci	50 to 100 Ci/yr	$1,100,000	$100,000	$11,100/Ci
PBF	As this is a recently designed facility, the system designs have been maximized for effluent control. Anticipated liquid effluent contamination levels from PBF will meet the drinking water standards[e] at the point of release from the facility.			[d]	[d]				[d]				Chemical contaminants removed from waste in this system as ion exchangers are already present.	None; use ICPP system	$51,000	N/A	Chemical contaminants removed from waste in this system as ion exchangers are already present.	$61,000	$10,000	N/A
TRA	Eliminate dumping of hot waste tank to seepage pit. 6 Ci	None	$50,000	$8,300/Ci	500 tons chemicals	$500,000	140,000	N/A	This is applicable only to the low-level liquid waste. ~200 Ci/yr	$900,000	$400,000	$2,500/Ci	Used only for high-level liquid waste. Curie reduction is small. Keeps 900 tons of chemicals from being released to lithosphere.	$500,000	$240,000	N/A	Used only for high-level liquid waste used in conjunction with alternate 3. Keeps 900 tons of chemicals from being released to lithosphere.	$315,000	$50,000	N/A

[a] Liquid waste treatment is for long-lived isotopes only.
[b] All waste system capital costs are amortized over 10 years although the facility may be disigned for a 30-year life.
[c] Not applicable for this type facility or effluent stream.
[d] Included in existing waste system design.
[e] AEC Manual Chapter 0524, Table II, column 2.

out and no longer considered an acceptable method for control of low-level radioactive wastes. Consequently, any one or any combination of the alternatives listed in Table IX-4 may be sought in reducing low-level radioactive liquid wastes that are now routed to seepage ponds.

(2) Sanitary Wastes

The sanitary wastes generated at INEL are handled in septic systems in all areas except CFA, ICPP, TRA, and TSF -- all of which have secondary processing plants. Owing to the wide separation of facilities, the low use factor, the large areas for seepage fields, and extreme distances water must travel before it surfaces, it is not practical to install more sophisticated sanitary waste systems.

c. Solid Waste Systems

(1) Radioactive

The radioactive solid waste management program is comprised of three facets:

(a) Radioactive calcined wastes, which are stored on an interim basis at ICPP

(b) Routine radioactive solid wastes, which are disposed of at the RWMC Subsurface Disposal Area

(c) Transuranic solid waste, which is stored on an interim basis at the TSA.

Interim storage of calcined radioactive wastes at INEL has been reviewed to determine the course of action that should be taken from environmental and cost-effective standpoints. Pending the availability of a national repository, the engineered interim solid storage facilities at ICPP, in conjunction with waste calcining, appear to be the most environmentally acceptable means of handling the solid fission product wastes at INEL. Failure to reprocess irradiated fuels or to calcine the liquid wastes from fuel reprocessing and reactor operations would require the construction of more costly storage facilities for highly radioactive liquid wastes or irradiated fuel elements. In addition, the alternatives do not have all of the environmental protection advantages of the storage technique now employed.

The routine radioactive solid wastes which are generated at INEL are disposed of by burial. Burial is a low-cost method of managing solid waste, particularly for a remote area such as INEL where land values are low. For example, burial costs at INEL are on the order of $1.10/ft^3. Radioactive wastes differ from toxic nonradioactive wastes in that isolation of the former from the populace is necessary until radioactivity decays to a safe level, whereas toxic nonradiological wastes must be either chemically destroyed or isolated until they deteriorate to a nonhazardous form. The only viable alternatives to the methods now employed and their estimated costs are encasement and engineered storage of the wastes ($27/ft^3) and encasement of the noncombustible wastes and incineration of the combustibles ($12/ft^3). It is judged appropriate on a cost-benefit basis to continue the burial of routine INEL solid radioactive wastes. Ninety percent of the radioactivity associated with this waste is induced radiation from activation of reactor components such as stainless steel and other alloys. These contaminants are rela-tively fixed within the metal component and therefore are immobile. In addition, this induced radiation is of short half-life (<5 years) which minimizes any potential environmental effect.

The transuranic-bearing wastes are mainly generated elsewhere and shipped to INEL for storage. In 1970 the AEC issued a directive requiring that all transuranic-bearing wastes generated and stored at its own sites be segregated and placed in a form which is readily retrievable. These wastes at INEL are placed in metal drums, stacked on a blacktop pad, and covered with an impermeable membrane and soil. Other alternatives to this method are the storage of the wastes in engineered storage facilities which might consist of large concrete bunkers or other enclosures. The relative costs for the two storage methods are (a) TSA storage, $1.17/ft^3; and (b) engineered storage in bunkers, $27/ft^3.

The present method of storing transuranic materials in TSA is considered adequate for the temporary nature of the storage. The additional cost for engineered concrete bunkers would not provide a calculable amount of additional safety.

(2) Nonradioactive

The nonradioactive solid waste management program has been reviewed to determine the course of action that can be taken from both environmental and cost-effective standpoints. Cost factors for land, physical facilities, equipment, and operations have been determined for the various alternative systems, and then compared with the qualitative and quantitative judgments of the environmental impact and technical and/or operational problems. Based on total cost to INEL, the following comparisons are given:

(a)	Previous open burning (estimate)	$ 2,000/yr
(b)	Haul to county disposal sites	13,700/yr
(c)	INEL sanitary landfill operation	18,900/yr
(d)	Bailing and landfill operation	24,400/yr
(e)	INEL thermal incineration in engineered systems	34,800/yr
(f)	Composting	68,600/yr.

The above costs do not include \$18,800/yr for solid waste storage, collection, and transportation; these were assumed to remain unchanged for the processing and disposal options considered.

The most cost-effective measure, open burning, is not a viable alternative because of present Idaho laws. The second most cost-effective alternative (waste disposed of by contract to county sanitary landfill areas) is not utilized because the next cost-effective method (operation of an INEL sanitary landfill) offers the advantages of control, flexibility, convenience, and safety.

E. CONCLUSIONS

Based on the cost-benefit analysis, it is judged that benefits obtained from operating INEL waste management systems outweigh the environmental costs identified by this statement. Continued operation of these present facilities is not expected to increase the environmental impacts on costs. Conversely, the existing environmental costs will be lowered as proposed improvements are made to the waste management systems. Additional improvements to these systems will continue to be investigated and implemented wherever practicable.